4.4 Fractional Exponents and Radicals

Lesson 5

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Connect **Fractional Exponents**

Powers with Rational Exponents with Numerator 1

When n is a natural number and x is a rational number, $x^{\frac{1}{n}} = \sqrt[n]{x}$

In Math 9, you learned that for powers with integral (same) bases and whole number exponents.

$$\boxed{a^m \times a^n = a^{m+n}}$$

We can extend this law to powers with fractional exponents with numerator (top number) 1.

$$\boxed{a^{\frac{1}{2}} \times a^{\frac{1}{2}} = a^{\frac{1}{2}+\frac{1}{2}}}$$

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Connect **Fractional Exponents**

Powers with Rational Exponents with Numerator 1

When n is a natural number and x is a rational number, $x^{\frac{1}{n}} = \sqrt[n]{x}$

We can extend this law to powers with fractional exponents with numerator (top number) 1.

$$\boxed{a^{\frac{1}{2}} \times a^{\frac{1}{2}} = a^{\frac{1}{2}+\frac{1}{2}}}$$

$a^{\frac{1}{2}} = \sqrt{a}$ which means they are equivalent

also, $a^{\frac{1}{3}} = \sqrt[3]{a}$ and the pattern continues

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POWERS WITH RATIONAL EXPONENTS

When "m" and "n" are natural numbers, and x is a rational number.

$$x^{\frac{m}{n}} = \left(x^{\frac{1}{n}}\right)^m$$
$$= \left(\sqrt[n]{x}\right)^m$$

and $x^{\frac{m}{n}} = \left(x^m\right)^{\frac{1}{n}}$
$$= \sqrt[n]{x^m}$$

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Connect — **Evaluate each Power**

Example 1:

$27^{\frac{1}{3}} = \left(\sqrt[3]{27}\right)^1$

$= \sqrt[3]{27}$

$= 3$

$40^{\frac{2}{3}} = \left(\sqrt[3]{40}\right)^2$

or $\sqrt[3]{40^2}$ $\rightarrow$ $\sqrt[3]{1600} = 11.7$

$= (3.41995)^2 = 11.7$

or =

STEPS:

Use the Power law to help change to a radical with the denominator as the index of the radical.

Evaluate the radical

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Connect — **Evaluate each Power**

Example 2:

$0.49^{\frac{1}{2}} =$ $\rightarrow$ Don't need to put index if 2

$\sqrt[2]{0.49}$

$= \sqrt{0.49}$

$= 0.7$

$0.04^{\frac{3}{2}}$

$= \left(\sqrt{0.04}\right)^3$

$= (0.2)^3$

$= 0.008$

STEPS:

Use the Power law to help change to a radical with the denominator as the index of the radical.

Evaluate the radical

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Connect — **Evaluate each Power**

Example 3:

$(-64)^{\frac{1}{3}} =$

$\sqrt[3]{-64}$

$= -4$

$27^{\frac{4}{3}}$

$= \left(\sqrt[3]{27}\right)^4$

$= (3)^4$

$= 81$

STEPS:

Use the Power law to help change to a radical with the denominator as the index of the radical.

Evaluate the radical

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Connect — **Evaluate each Power**

Example 4:

$\left(\frac{4}{9}\right)^{\frac{1}{2}} = \sqrt{\frac{4}{9}}$

$\frac{\sqrt{4}}{\sqrt{9}} = \frac{2}{3}$

$\left(\frac{16}{81}\right)^{\frac{3}{4}} = \left(\sqrt[4]{\frac{16}{81}}\right)^3$

$= \left(\frac{2}{3}\right)^3 = \frac{2^3}{3^3} = \boxed{\frac{8}{27}}$

STEPS:

Use the Power law to help change to a radical with the denominator as the index of the radical.

Evaluate the radical

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Connect **YOU TRY!**

$1000^{\frac{1}{3}}$	$0.25^{\frac{1}{2}}$	$0.01^{\frac{3}{2}}$	$(81)^{\frac{3}{4}}$
$\sqrt[3]{1000}$	$\sqrt{0.25}$	$(\sqrt{0.01})^3$	$(\sqrt[4]{81})^3$
$= 10$	$= 0.5$	$(0.1)^3$	$= (3)^3$
		$= 0.001$	$= 27$

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Connect **Evaluate each Power**

Example 5:

$\frac{4}{10} = \frac{2}{5}$

$$(-32)^{0.4} = (-32)^{\frac{2}{5}}$$

$$= (\sqrt[5]{-32})^2$$

$$= (-2)^2$$

$$= 4$$

STEPS:

Change decimal exponent to fractional first

Use the Power law to help change to a radical with the denominator as the index of the radical.

Evaluate the radical

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Practice **HOMEWORK!**

Textbook Questions:

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